
Space Weather Technical Forecast

Issued on Monday, 16 January 2023 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further R1/R2 Radio Blackouts Expected throughout. Risk G1 rising from midweek.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, with two M-class flares observed at GOES16. The largest of these events was an M6.0 at 14/0341UTC from emerging region AR3191 on the northeast limb. The other, a M4.8 at 15/1432 UTC, was observed emanating from AR3190 in the southeast.

The solar disc remains highly congested in terms of sunspot regions, particularly the eastern solar horizon, with 10 sunspots at present including the aforementioned AR3190 and AR3191. The main sunspots of note on the disc were those containing potential weak Mt Wilson delta spots (3182 and 3186) as well as the growth trends in AR3190, AR3191 and AR3192 in the east.

There was a clear partial halo signature associated with a lift off near AR3182 as a result of the two consecutive M-class flares. This feature has been analysed and suggests a risk of affecting Earth at the very end the UTC day of Wednesday 18 January, with effects ongoing into Thursday. Another visible CME associated with the 15/0341UTC flare was observed heading largely south and east on LASCO, with this feature analysed and MOSWOC Enlil results indicating its path to travel ahead of Earth orbit.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by DSCOVR and ACE showed a slight decreasing trend from 500 km/s to around 420 km/s by 15/1800 UTC with a slight increasing trend back to around 510 km/s by the end of the period, likely due to waning CH effects initially then with CME effects by the end of the UTC day. The solar wind density appeared on a mostly flat trend until 15/1800 UTC when it began rising, reaching a peak of 28ppcc by 15/2332 UTC. The IMF followed a moderate but flat and predominantly negative trend initially, then became weak and mostly positive from 15/2300 UTC. The Bz reached -10nT. The phi angle was mostly negative (towards the Sun) until 15/2300 UTC when it became mostly positive (away from the sun). The net result of the above solar wind measures was a mostly Active spell (Kp4), bookended by G1/Minor Storm intervals (Kp5).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been very near Background levels.

High energy electron flux (greater than 2 MeV) has varied between Normal Background to Moderate levels on a typical diurnal cycle. The 24-hour integrated electron fluence stayed well below the Active threshold on a very slight increasing trend, reaching 6.78e6 integrated pfu by 16/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Expected to be Moderate, with a daily Slight Chance of X-class flares. Although one of the more active regions departs the front side by midweek UTC, the sheer weight of current and expected eastern solar hemisphere arrivals should serve to compensate.

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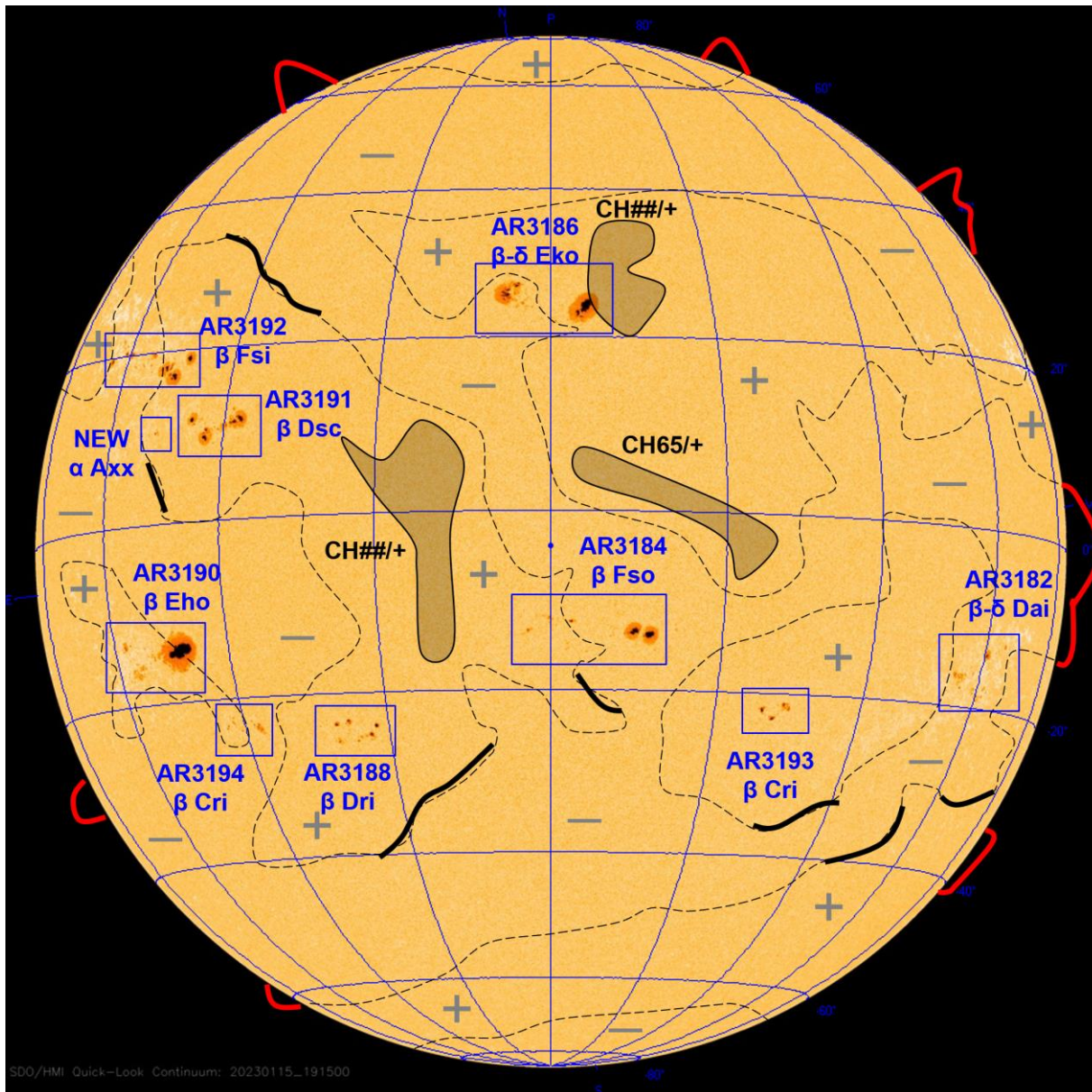
Solar Wind / Geomagnetic Activity: Solar wind speeds are expected to ease through day 1 (16th) due to fading CH and CME effects. A largely Quiet environment succeeds this. Day 3 (18th) may see wind speeds rise to 450-500km/s due to the faint CH65/+. There is then the risk of a CME from the AR3182 twin M-flares of 14 January arriving later day 3 or day 4 (18th or 19th).

There is an initial Slight Chance of further G1 intervals on day one before a lull, rising to a Chance on 18th or 19th to combined CH and CME arrivals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly Background levels, but with a Slight Chance of enhancements to S1 or greater through the period due to a number of magnetically complex sunspot regions on the visible disc.

The high energy electron flux (greater than 2 MeV) is expected to continue at Normal Background to Moderate levels, possibly with a slight upward trend, but insufficient for the corresponding electron fluence to breach Active ($1e8$ integrated pfu).

Figure 1. Solar Analysis Valid 15/2000 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Initially, there are ongoing remnants from the 09 and possible 11 January CMEs on the heels of fading CH62's high speed stream. A largely Quiet environment succeeds this through the working week until Wednesday 18th when the Earth may enter the minor fast wind regime from a weakly-defined coronal hole near centre-disc at present, labelled CH65/+. The sheer number of active regions have served to obscure this hole to some extent, but should it survive, MOSWOC Enlil suggests 450-500km/s is feasible. There is also a risk of a CME from the AR3182 twin M-flares of 14 January arriving to end of 18th or into 19th.

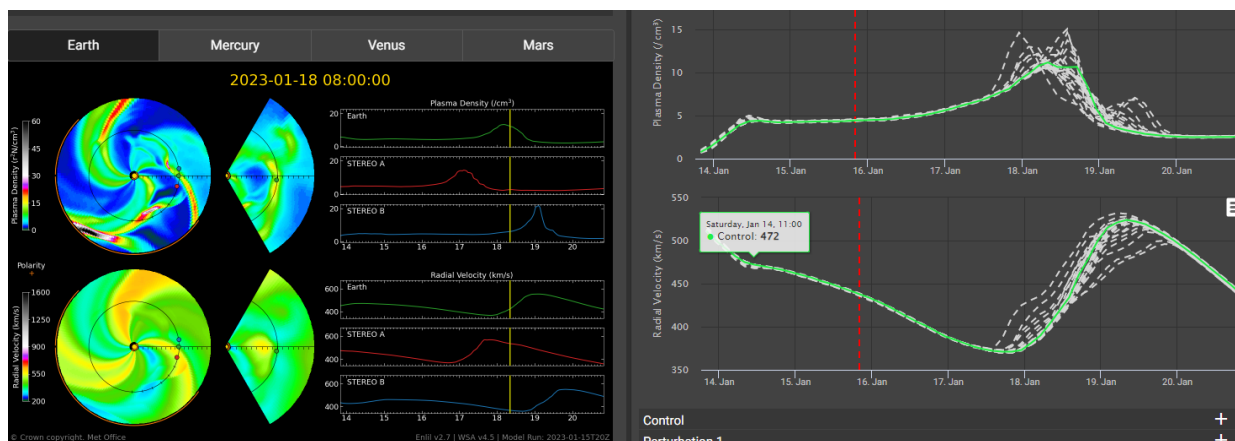
The above should see an initial Slight Chance of further G1 intervals on day one before a lull, rising to a Chance on 18th or 19th.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	1	30	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/0900 UTC	Partial	AR3182	SW Quadrant	400 km/s	End of 18 th or early 19 th .	Probable hit, reasonable confidence. Onset time lower confidence.

Figure 2: MOSWOC Enlil run and ensemble, showing the 14/2000UTC twin M-class CME arrival.



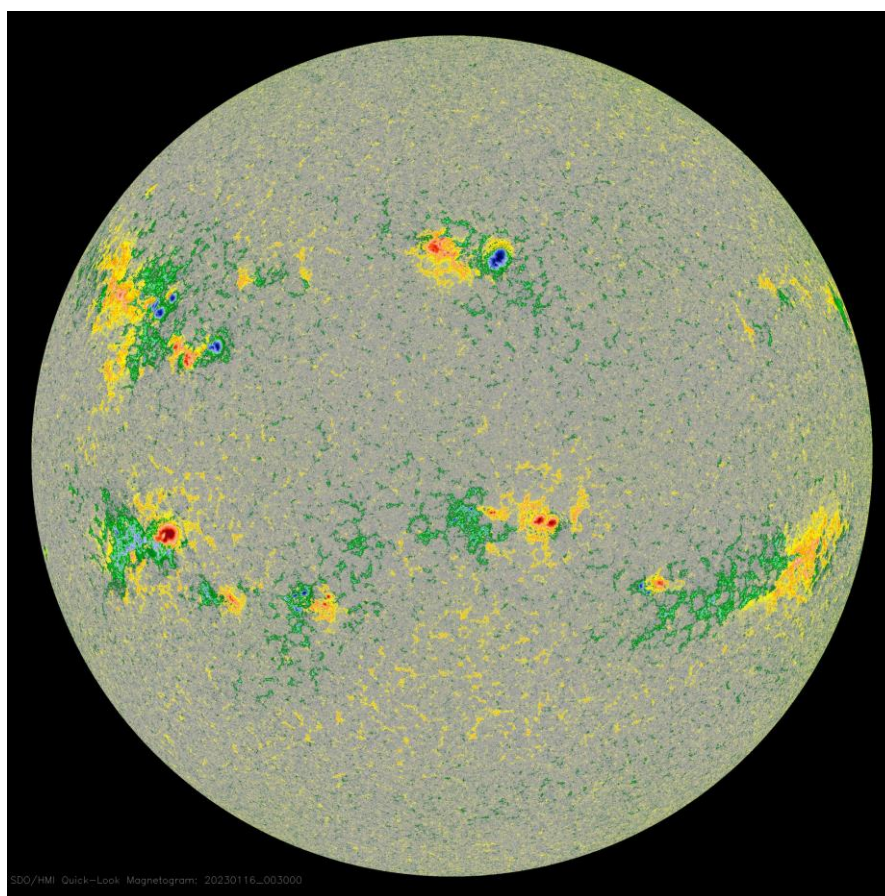
Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate and is expected to continue Moderate going forward given the current complex population of sunspot groups on the disc.

Regarding the balance of front-sided sunspot groups, AR3182 should leave the Earth-facing side by midweek UTC, however the vast majority of major contributors to the flare risk should remain, with these very likely to be joined by further active regions over the eastern solar horizon given evidence on far-side soundings. So, while one noteworthy region does eventually depart, on balance the risk of M-class flares is held constant.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: Recent Magnetogram showing complexity of all spots facing Earth.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is currently very near Background levels.

While no recent S1+ events have been observed at GEO, the sheer number of both front and far-sided complex groups dictates a raised risk, with the raw probabilities for the disc as a whole based on their Zurich classes held still higher by the recent presence of Ex-AR3181 on the western limb. While the relative contribution to risk will decrease into the new UTC working week for Ex-AR3181, the weight of sunspot regions in the eastern solar hemisphere will increasingly bring itself to bear, resulting in a relatively constant Slight Chance of S1+ through the four days.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux is oscillating between Normal Background and Moderate levels as part of the normal diurnal variation. The recent fast wind from CH62/- is now tailing off and has yet to manifest in any increased magnitude oscillation, however it is more likely than not that it will elicit some form of upward reaction this week. The degree to which this occurs will most likely prove insufficient for 24-hour Active fluence to be realised, given the modest duration and intensity of the fast wind.

Persistence methods are not considered useful in the period given the lack of similarity of the current disc with last pass, as well as the presence of CMEs, however REFM is in agreement in the persistence of a sub-Active trend.

All considered, there is a slightly upward trend possible in flux and fluence, but probably peaking by Wednesday 18th, with the CME arrivals later on 18th or on 19th likely to reduce the electron count further.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	10	20	20	10
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

Figure 5: Latest REFM showing fluence/integrated flux observations, forecast and persistence.

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